



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

ON THE AFFINITIES OF CERTAIN ANOMALOUS DICOTYLEDONS.

DOUGLAS HOUGHTON CAMPBELL.

THERE is still a difference of opinion among botanists as to the relationship between the two great divisions of angiospermous plants, monocotyledons and dicotyledons. The two groups have evidently been derived from a common stock, but which branch is the older is still somewhat doubtful.

Among the genera commonly referred to the dicotyledons are several which differ from the typical forms both in the structure of the flowers and in the character of the tissues, especially the structure and distribution of the vascular bundles. Among these anomalous dicotyledons may be mentioned the Nymphæaceæ, certain Ranunculaceæ (*Actæa*, *Thalictrum*), and among the Berberidaceæ, *Podophyllum*, *Diphylleia*, and *Caulophyllum*.

A recent paper¹ on the embryo of *Nelumbo* has called attention to the importance of a thorough study of these anomalous genera, whose embryogeny is almost completely unknown.

The result of Lyon's examination of *Nelumbo* was the discovery that the apparently dicotyledonous embryo has really but a single cotyledon and resembles that of the aquatic *Alismales*, an order of monocotyledons that shows numerous analogies with the Nymphæaceæ.

This interesting discovery suggested to the writer the advisability of looking up what had been already done with the study of the embryos of some of the other forms referred to, and although the results of these inquiries have been very incomplete, they have revealed a number of extremely suggestive facts, which are here given, and which emphasize the desirability of more thorough work in the same direction.

¹ Lyon, H. L. *Minnesota Botanical Studies*, Ser. 2, pt. v, 1901.

NYMPHÆACEÆ.

In several respects the Nymphæaceæ suggest the Alismales, rather than the dicotyledons, with which they are usually associated. Some of the earlier botanists, among them Jussieu, considered the Nymphæaceæ as true monocotyledons; but all later botanists have agreed in placing them with the Polycarpicæ, or Ranales, among the most primitive of the dicotyledons. The discovery that *Nelumbo* has a monocotyledonous

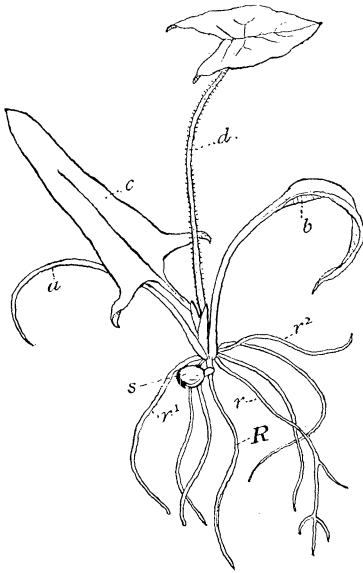


FIG. 1. — Seedling of *Victoria regia*, showing the sagittate form of the early leaves. (From Goebel, after Trécul.)

embryo at once raises the question whether the other genera are also monocotyledonous. The structure of the flowers, especially in the simpler genera, *Cabomba* and *Brasenia*, is very much like that in some of the Alismales, and the character of the vascular bundles, as well as their arrangement in all the Nymphæaceæ, is similar to that in the typical monocotyledonous stem. The form of the leaves, also, is often very suggestive of the sagittate leaves of *Alisma* or *Sagittaria*. This is seen in *Nuphar*, especially when growing in shallow water, and the early leaves of other Nymphæaceæ (Fig. 1) are re-

markably similar to those of *Sagittaria*. Whether or not this resemblance of the young leaves of these Nymphæaceæ to those of the Alismales is really an indication of relationship, it is worth noting in connection with the other points of resemblance.

From Lyon's studies upon the embryo of *Nelumbo* it appears that in this genus the apparent two cotyledons are the result of a bifurcation of a single cotyledon. The stem apex arises laterally as in typical monocotyledons, and, as in these, the

cotyledon enwraps the plumule, which becomes largely developed. In *Aponogeton*, one of the *Alismales*, the sheathing base of the single cotyledon develops a pair of stipule-like lobes, which remotely suggest the two large lobes described for *Nelumbo*.

Whether the other *Nymphæaceæ* will show a monocotyledonous embryo remains to be seen, and the removal of the family to the *Alismales* is, perhaps, premature.

RANUNCULACEÆ.

A number of *Ranunculaceæ* resemble superficially the *Alismales*, especially as regards the structure of the flowers. The genus *Echinodorus*, of the *Alismaceæ*, for instance, has flowers closely resembling those of *Ranunculus*. Other *Ranunculaceæ*—*e.g.*, *Actæa*, *Thalictrum*—have the vascular bundles arranged much as in the typical monocotyledons instead of in the single ring characteristic of the typical dicotyledons.

Ranunculus ficaria has but a single cotyledon, which it is usually supposed is the result of the abortion of one of two cotyledons; but this has not been demonstrated, and it is barely possible it may prove to be truly monocotyledonous. Certain peculiarities in the embryos of other genera, which will be referred to later, point to the possibility of the embryo in these forms also having but a single cotyledon.

One important difference, however, must be noted between the *Ranunculaceæ* and the *Alismales* or *Nymphæaceæ*. In the two latter groups the embryo in the ripe seed is large, with very little endosperm about it. In the *Ranunculaceæ* the embryo in the ripe seed is always minute and is surrounded by abundant endosperm.

ANOMALOUS BERBERIDACEÆ.

Under the *Berberidaceæ* are generally included several peculiar genera of somewhat doubtful affinities. Of these, *Jeffersonia*, *Podophyllum*, and *Diphylla* are especially interesting, as they are all small genera of peculiar distribution, being

represented in eastern Asia and Atlantic North America, but not occurring elsewhere. This points to their being old types which have persisted in these two widely separated regions, and adds to the interest in their history.

The development of the embryo is quite unknown in all of them, but the germination has been observed in *Podophyllum*,

both in our native *P. peltatum* and in the Asiatic *P. emodi*, which agrees closely with *P. peltatum*.

The latter species has been carefully studied by Holm,¹ and there are certain peculiarities in the germination, which, in view of the recent discovery in *Nelumbo*, are extremely significant. According to Holm (and the same is shown by Lubbock for *P. emodi*) there are apparently two cotyledons, with completely united, much elongated petioles, which form a hollow tube, at the base of which the plumule is placed (Fig. 2, *B*). The latter finally breaks through the base of the cotyledonary tube.

There would be nothing especially significant about

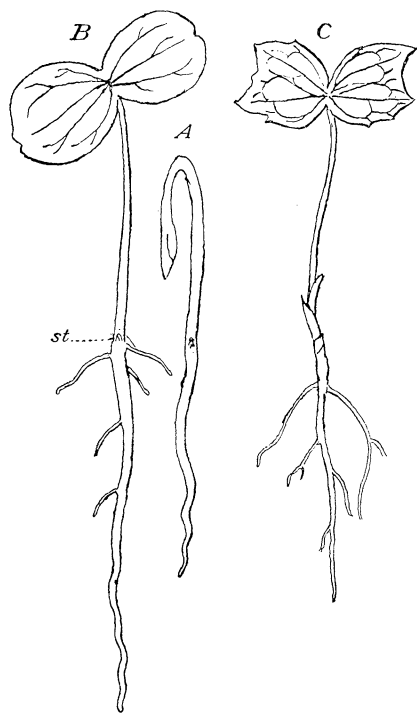


FIG. 2. — *A, B*, seedlings of *Podophyllum peltatum*, showing the coherent (?) cotyledons, and the plumule (*st*) at the base of the cotyledonary sheath. *C*, young plant in the second year; the bilobed leaf closely resembles the cotyledon. (After Holm.)

this were it not found that the second leaf, as shown by Holm's studies, is deeply bilobed (Fig. 2, *C*) and resembles to an extraordinary degree the supposed pair of cotyledons. The thought was at once suggested, — Is not the supposed pair of cotyledons in *Podophyllum* really a single one, as in *Nelumbo*, the two apparent cotyledons being merely lobes of a single

¹ *Botanical Gazette*, 1899.

leaf? This view is much strengthened by the persistence of the bilobed form in the leaves of the young plant for several years, and the permanently binate leaves of the allied genera *Jeffersonia* and *Diphylleia*. The position of the plumule at the base of the cotyledonary tube suggests a possible lateral origin for this, as in typical monocotyledons and in *Nelumbo*. The character of the flowers and the tissues in *Podophyllum* and *Diphylleia*, as well as in *Caulophyllum*, are in accord with a possible monocotyledonous affinity for these forms. It is, at any rate, highly desirable that a careful embryological study should be made of these extremely peculiar plants.

The formation of a cotyledonary tube apparently similar to that in *Podophyllum* has been described for a number of widely separated forms, *e.g.*, *Anemone*, *Delphinium*, various *Umbelliferae*, *Megarrhiza californica*, *Dodecatheon meadia*.¹ Whether in all of these there is really a coherence of two cotyledons must be determined by a study of the embryogeny.

It is evident that the last word has not yet been spoken as to the interrelationships of the angiosperms. The numerous studies upon the development of the embryo sac, which have appeared during the past few years, have shown that there is much more variation in the structures of the embryo sac than was supposed to be the case. The most marked departure from the angiospermous type is the genus *Peperomia*. The embryo sac of this genus has regularly sixteen nuclei instead of the eight usually present, and in this respect shows an approach to the condition obtaining among the gymnosperms and higher pteridophytes.

Peperomia, which appears to be genuinely dicotyledonous, nevertheless in the structure and distribution of the vascular bundles, as well as in the character and arrangement of the flowers, approaches some of the simpler monocotyledons, especially the *Araceae*. It seems possible, as the writer has elsewhere suggested, that there may be two points where the two great divisions of angiosperms come together.

From the evidence at hand it would appear that the two phyla—monocotyledons and dicotyledons—are of about equal

¹ Holm, *loc cit.*, p. 422.

antiquity; but as a whole, the former have remained simpler than the dicotyledons. The scattered, closed vascular bundles probably represent a more primitive type of structure than the ring of open bundles characteristic of the more highly developed dicotyledons.

It is exceedingly important for a clear understanding of the affinities of such anomalous types as *Podophyllum* that a complete study should be made of the development of the embryo sac and embryo. Results of importance ought to reward the student who will make a critical study of the development of these puzzling forms.

LELAND STANFORD JR. UNIVERSITY.